Department of
Agriculture and Forestry

Prince Edward Island Soil Quality Monitoring Report (1998 -2000)

Agriculture is one of Prince Edward Island's (PEI) key industries and it is dependant on the quality of its soil. Soil is a living resource and can be damaged if not properly managed, so soil requires environmentally sustainable practices that will protect its productive capacity for future generations. *Soil quality* is the term most often used to integrate descriptive and analytical measurements of the physical, chemical and biological components of soil. In order to protect this resource, a baseline of the current soil properties must be determined. Only then can we compare future soil conditions and quality to determine if our farming practices are indeed environmentally sustainable.

Soil is a dynamic medium that contains mineral nutrients and a living ecosystem which can be described by a variety of physical, chemical and biological properties. Due to the dynamic nature of soil, quality is not measured by any one test or condition. While much attention is currently focused on nutrient management, other aspects of soil health and quality are also under investigation. Soil organic matter content, soil structure and biological diversity are all considered to be useful guides for measuring the state of the soil ecosystem, soil health and soil quality.

Monitoring any minor changes in these soil components may also signal the beginnings of soil improvement or degradation, and thus enable the early detection of changes in soil quality. Identification of any adverse trends in soil quality is a prerequisite to developing farm management strategies which are able to reduce, delay or reverse those trends. In the long term, this knowledge will enable producers to maintain and improve the capacity of their farmland to generate wealth for future generations.

As we continue to produce crops, the baseline conditions of PEI's soil must stay consistent or improve. Potatoes are a potentially "soil draining crop" as this crop typically removes more organic matter from the soil than is replaced, so soil quality has become a very important aspect of sustainable farming on PEI. More than 170,000 hectares of land is farmed by 2217 farmers. One of the most prominent Island crops is potatoes. In fact, more than 600 farms produce potatoes. The average farm size is 120 hectares while the average potato farm is 215 hectares. (Statistics Canada, 2002)

The long term effect of intensive farming practices on soil health is becoming a matter of concern. It is felt that soil quality may deteriorate through continuous agrichemical inputs and loss of productive topsoil through erosion. In the 1996 Speech from the Throne in the province of Prince Edward Island, the government announced the development of a Resource Land Use Strategy. The Round Table proposed that a soil monitoring system be developed which included three components; soil quality, soil loss and land management. The specific recommendations were:

Recommendation 18

We recommend that organic matter content be adopted as the principal indicator of soil quality for Prince Edward Island and that three percent be established as the minimum standard for good-quality agricultural land. We also recommend that the necessary changes be made to the provincial Soil and Feed Testing Laboratory for the fiscal year 1998-99 to enable the use of the method to complete carbon combustion for measuring soil organic matter.

Recommendation 19

We recommend that the Department of Agriculture and Forestry and Agri-food Canada continue the development of a comprehensive soil quality index to include the following indicators: organic matter, soil acidity (pH), phosphorus content and cation exchange capacity, and that the index be in operation for the 1998 field season.

Recommendation 20

We recommend that the federal and provincial governments finance the initial establishment of a province-wide soil quality monitoring network and that this network be in operation by the 1999 field season.

The overall purpose of the project is to determine and report changes in Prince Edward Island soil quality by: setting up a process to measure soil quality, establishing soil quality indicators, measuring soil quality on an on-going basis, and reporting results to the public. This project will provide information to policy makers, researchers and the general public about Island soil quality and, over time, the trends in soil quality. As a result of having this information, programs and policies can be developed to influence these trends, if necessary. Farmers can use the information to make more informed decisions about land use practices.

This report summarizes results observed for the first three years of data collection in reference to the Round Table Recommendations. As data collection proceeds over time, methods may be employed to determine if the relationships or associations observed in the initial data hold up over time.

Sampling Procedure:

Determining Sample Locations

The Canadian Forest Inventory Committee in conjunction with the Canadian Forest Service had recently developed a sampling grid for Canada to be used in the proposed National Forest Inventory (NFI). (CFIC,1998). This four kilometer grid was generated for all of Canada and the section of

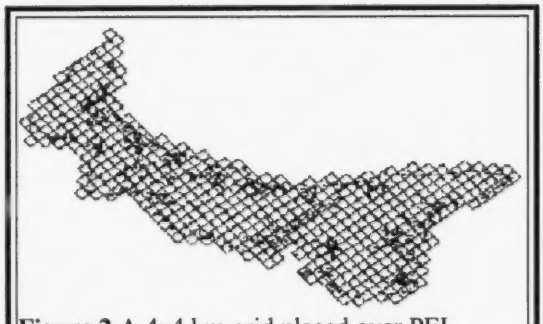


Figure 2 A 4x4 km grid placed over PEI. Each intersection represents a potential sampling point.

the grid which falls on PEI was used as the basis for this soil monitoring project. The grid was provided to the PEI Forestry Division in electronic form and was loaded into their Geographic Information System (GIS). Each intersection represents a potential sampling site.

Figure 3. Sampling sites with sampling locations in each of the 4 cardinal directions.

There were 391 intersections of the grid which were retained. This number was considered to be statistically insufficient. Therefore each location was changed to a cluster of five sampling points by calculating the coordinates of a point 100 metres in each cardinal direction from the grid intersection. This was an efficient method of increasing the number of sample points and keeping the travel costs involved in conducting the field work reasonable. The number of potential sampling points was determined to be 1896.

The land use mapping from the 1990/92 PEI Forest Biomass Inventory was initially used to classify the sampling points as; off the coast, forest or non forest. Non agriculture sites were discarded from the site locations and the result was 796 sampling points that were determined to be on agricultural land in 232 locations.

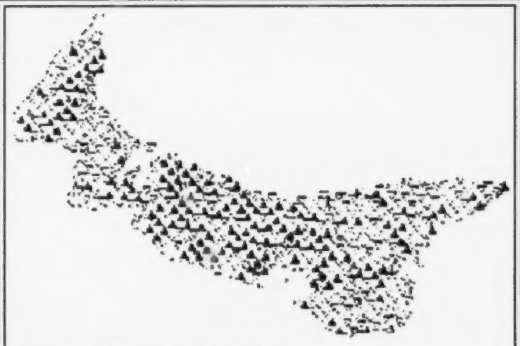


Figure 4 Sampling locations:

sample sites in agriculture

sample sites not in agriculture.

The design committee determined that if one third of the sample locations were measured each year, data that could indicate a change in soil quality would become available beginning in year four. The three year cycle was also feasible from a logistical point of view in getting the field work done in the narrow time window that would give the most consistent results in regards to soil nutrient levels.

Figure 5. Sample Collection using GPS Equipment

Maps were produced by GIS for each of the sampling locations. The land owners were also determined by the GIS using the Provincial digital property files. The land owners on which the randomly selected sites are located were informed by letter. The coordinates of each sample location were printed out for the field crews as well as down loaded in to Global Positioning System (GPS) receivers. (Note, the datum for the plots is NAD 1927.) These receivers allowed for 'real time' correction to allow the field crews to locate each sample point. The actual sampling sites can be repeatedly located within a one metre accuracy using the GPS equipment.

Collecting Soil Samples

The samples were taken in the three week period in the spring after the frost was out of the ground and before spring tillage or crops were planted. It was important to sample at the same time every year to give the most consistent results in regards to soil nutrient levels. The first third of the samples were taken in the spring of 1998, the second in the spring of 1999 and the last third during the spring of 2000. In the year 2001, the first set of replicate samples were collected.

A 4 litre composite soil sample was collected at each sampling site by augering at the centre location and at four locations equally spaced around the circumference at a radius of 20 feet from the centre point. Samples were collected from the soil surface to a nine inch depth to be included in the composite sample.

Testing and Analysis

Physical Data Results

The following physical parameters were measured for each sampling location: land use, depth of A & B horizons, the length and degree of slope above the sampling point and soil type. These were used to develop relationships with various chemical and biological properties.

Figure 6 Leco CNS 2000 was purchased and used for organic matter analysis.

Chemical Testing

Each sample was analysed at the PEI Soil & Feed Laboratory. The major macronutrients (N, P, K, and Ca) were determined as well as the micronutrients (Mg, Cu, Zn, Fe, Mn, S, and B), OM, pH, Buffer pH and CEC values.

In 1998, the Leco CNS-2000 was purchased and used in the analysis of all project samples as was specified in Recommendation 18 of the Round Table Report. The instrument used a combustion method to determine the organic matter and the carbon to nitrogen ratio.

Observations and Results

Chemical Data Results and Observations

The project is currently in its 5th year, so each location has been sampled once, and the samples collected in 2001 were the first set of replicates. All data collected with the project has been electronically stored at the PEI Department of Agriculture and Forestry for future analysis and interpretation. As of yet, no trends can be reported, but baseline results have been recorded for future comparisons.

The soil samples were categorized as one of 2 types: Charlottetown and Alberry. Charlottetown soils are well drained and make up the largest percentage of the overall soil type on PEI. These soils are well suited to agriculture crops. They are acidic with medium to low organic matter levels and low nutrient levels in the rooting zone. Alberry soils are well drained, strongly acidic, have low organic matter levels and possess low fertility in their natural state. (MacDougall, Veer and Wilson, 1988)

Almost all values for the baseline data fall within intervals given by standard crop rate tables used by the PEI Soil and Feed Laboratory. Table 1 gives the mean values of the chemical data collected in each of the initial three sampling years.

Table 1. Mean values for each of the three baseline years.

Chemical Test	1998 (n = 253) Mean (Std dev)	1999 (n=217) mean (Std dev)	2000* Mean (Std dev)
pH	5.95 (0.38)	5.93 (0.41)	5.89 (0.40)
Phosphate (ppm)	337.3 (197.4)	308.0 (176.5)	366.6 (203.7)
Potassium (ppm)	141.68 (65.98)	138.07 (67.55)	153.24 (86.8)
Calcium (ppm)	811.0 (276.9)	821.7 (293.2)	817.7 (305.4)
Magnesium (ppm)	110.7 (48.11)	113.15 (46.95)	113.09 (44.79)
Boron (ppm)	0.41 (0.37)	0.38 (0.13)	0.36 (0.16)
Copper (ppm)	1.44 (0.99)	1.51 (1.79)	1.51 (1.37)
Zinc (ppm)	2.19 (1.42)	2.28 (1.89)	2.02 (1.31)
Sulfur (ppm)	24.66 (11.12)	31.27 (20.06)	32.46 (7.56)
Manganese (ppm)	73.75 (65.2)	68.02 (37.99)	65.75 (35.94)
Iron (ppm)	225.98 (82.24)	249.21 (84.56)	232.24 (91.35)
Sodium (ppm)	12.88 (5.56)	37.79 (29.75)	34.54 (10.97)
Nitrogen	0.19 (0.04)	0.16 (0.05)	0.16 (0.03)

** Sample size for all cells is n= 237, except for Nitrogen for which n = 67*
**2/3 of observed within one standard deviation of mean

Index for Soil Quality

It was suggested that organic matter be adopted as the principal indicator of soil quality on PEI. Three percent was the value selected by the Round Table as a baseline for organic matter. Forty nine percent of the soil samples that were analyzed for land that was in the potato rotation had an organic matter level that was less than the three percent target selected by the Round Table. Of the soil samples, 31.8% for all other land uses had organic matter levels less than 3 percent. Figure 7 illustrates the percentage of samples which fell within the six result ranges used by the Soil and Feed Laboratory.

Recommendation 19 by the Round Table suggested that a comprehensive soil quality index would include other indicators such as soil acidity and phosphorus content. Figures 8 and 9 show the initial results for these two parameters. It has yet to be determined if a single index can be comprehensive enough to indicate soil quality.

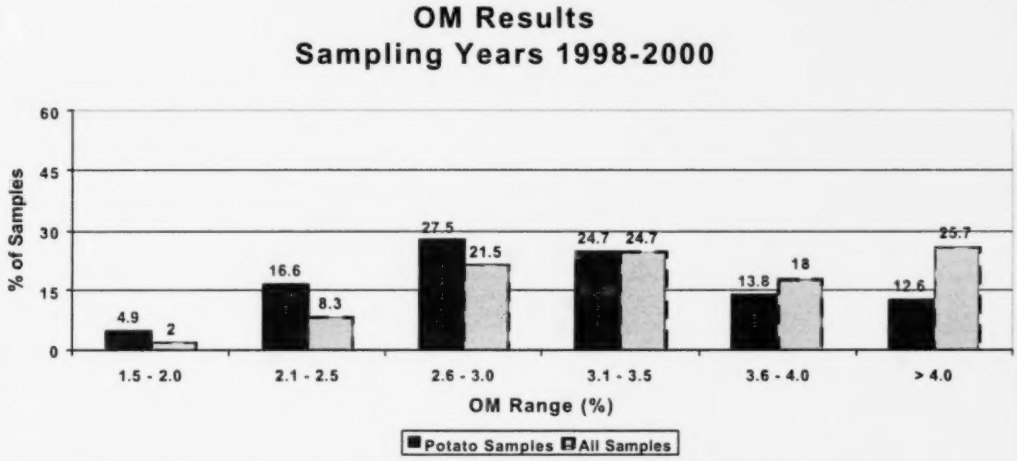


Figure 7 comparison of organic matter results for all samples versus potato soil samples

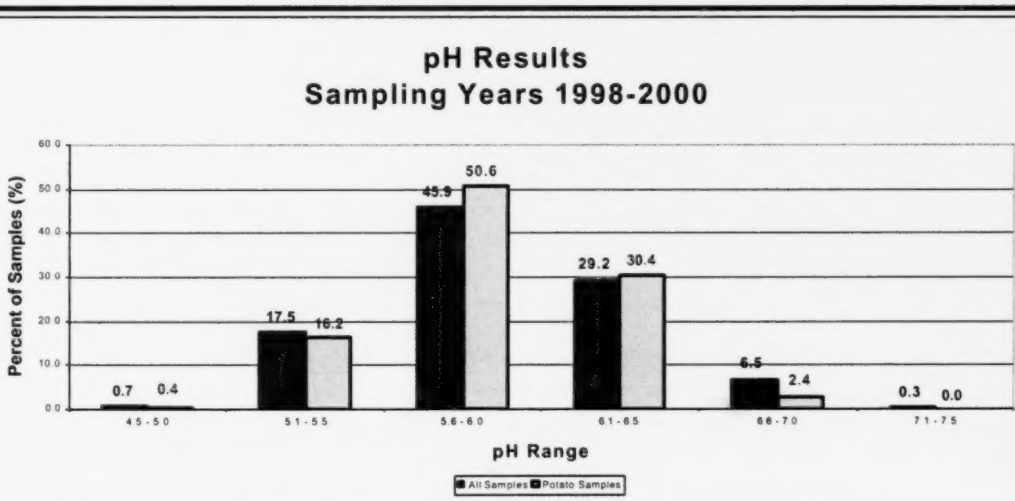


Figure 8 Comparison of soil acidity results for all samples versus potato soil samples.

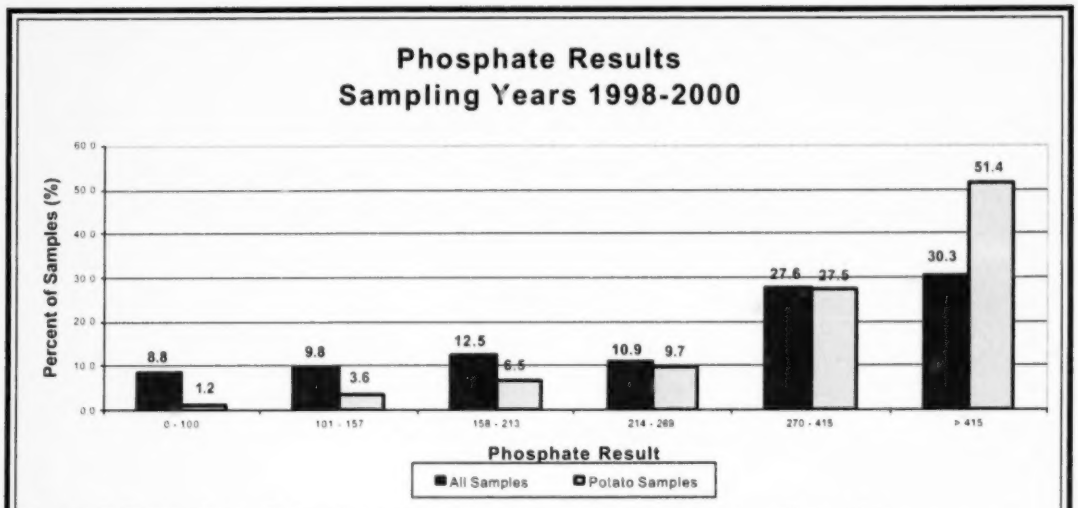


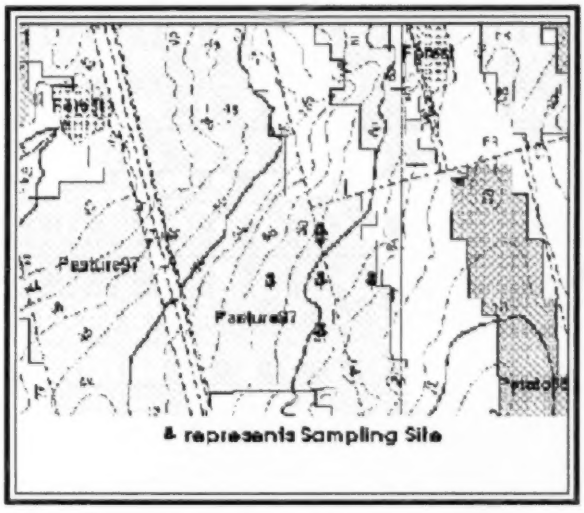
Figure 9 Comparison of phosphate results for all samples versus potato soil samples

Benefits of Network Data

Using the coordinates of the sample plot locations on the GIS system, other attributes have been added to the data sets for each location. Information from satellite images showing previous land use as well as the soil series from the digital soil mapping has been added to the data set. The chemical and physical databases to date have been incorporated with GIS images. This has allowed us to view existing conditions across Prince Edward Island.

Also, data from physical parameters such as slope can instantly be compared with the cropping history by selecting and overlapping the required layers while also showing specific sampling locations as seen in Figure 9.

Some chemical data results can also relate to cropping history. Hay, potato and grain soil samples were all rich in the major nutrients N, P and K.



Data can continually be added to elaborate on the existing conditions at each sampling location and provide a great deal of data for other studies. In the future, it will also be possible to detect samples results that are outside an expected ranged.

Conclusion

Based on current data, the soil quality monitoring project has established baseline for the current soil quality conditions on PEI. This system of determining soil conditions will allow for detection of changes in soil quality which in turn will influence the programs and policies required for maintaining a high soil quality on PEI.

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Atlantic Canada Opportunities Agency
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Canada

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